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ABSTRACT

The study involving 32 trainable mentally handicapped students (7 to 20 years old) investigated the effectiveness of computer assisted instruction (CAI) in teaching the necesary arithmetic skills for handling small amounts of money. Equipment used consisted of a Cathode Ray Tube (CRT) terminal interfaced with a random access slide projector, and a hard copy teletype terminal. Courseware consisted of a series of computer programs organized into four models (numeral recognition, counting to 99, simple addition, coin recognition), each of which dealt with a concept necessary for successful handling of coins up to 99 cents. Although the modules followed a sequential developmental design, it was not necessary for a student to complete one module before advancing to the next. Results showed that while learning took place for both the study and control groups, the difference was statistically significant for the study group. (Author/SB)

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COMPUTER ASSISTED INSTRUCTION FOR TEACHING BASIC MONEY HANDLING SKILLS TO MENTALLY HANDICAPPED STUDENTS AT CHRISTINE MEIKLE SCHOOL IN CALGARY

PROJECT DIRECTOR
Else Holz

A Study Conducted under Contract to
Alberta Education,
Edmonton, Alberta

April 30, 1979

EC 141504

ABSTRACT

The purpose of this study was to investigate the effectiveness of computer assisted instruction (CAI) in teaching the necessary arithmetic skills for handling small amounts of money to mentally handicapped students at Christine Meikle School in Calgary.

The terminal equipment used in the study was a Cathode Ray Tube (CRT) terminal interfaced with a random access slide projector, and a hard copy teletype terminal.

The courseware consisted of a series of computer programs organized into four modules, each of which dealt with a concept necessary for successful handling of coins up to 99 cents. These concepts included numeral recognition, counting to 99, simple addition, and coin recognition. Both CRT screen displays and slides were used for the presentation of the material to be learned. Although the modules followed a sequential developmental design, it was not necessary for a student to complete one module before advancing to the next. Thus, for example, if a student had mastered addition up to 5, he was passed along to drill in simple coin recognition, through to the module which dealt with adding 5 pennies and introduction of a nickle.

A sample of 32 students were selected for the study. These students were matched according to the pre-test results and were randomly assigned to either the study group or the control group.

The results of the study, based on an analysis of the post-test scores for the two groups, showed that while learning took place for both the groups the difference was more marked for the study group. Through their interaction with CAI, the students in the study group improved to a statistical degree, significant beyond the .001 level of confidence, clearly indicating that computer assisted interaction offers a viable and effective method of teaching basic money handling skills to the mentally handicapped at Christine Meikle School.

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Else Holz,
April 1979

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CHAPTER 1

BACKGROUND

Introduction to the Problem

One of the aims of Social Education is to provide the necessary knowledge and skills to gain familiarity with everyday situations, and thus enable a person to function safely and effectively within the structure of society. Social Education for the mentally handicapped is concerned with such skills which are considered necessary for their successful integration into their environment. In order that they may live and work with other people rather than in institutional isolation it is essential that their social education include training in basic skills for money handling.

Because of the wide range of abilities and individual differences among the mentally handicapped, such training, to be effective, should be conducted in an individualized instructional setting in which the learner progresses through a predetermined sequence of learning material at his own rate of speed. This, however, would prove both time consuming and costly if conducted in the conventional person-to-person manner.

The computer offers a practical alternative. Computer Assisted Instruction (CAI) uses time-sharing terminals to facilitate a man-machine interaction, and it employs techniques which have several advantages over other forms of instruction for the mentally handicapped. Thus, a well designed CAI system can adapt to the needs of each individual learner by incorporating training features such as small logical steps, active participation, immediate feedback, overlearning, selfpacing and testing.

Problem

The purpose of this study was to explore alternative means of providing the mentally handicapped with such individualized social education as is essential for their successful integration. Through use of CAI an attempt was made to solve the problem of teaching the necessary arithmetic skills for handling small amounts of money to the students at Christine Meikle School in Calgary.

Review of Computer Assisted Instruction with the Mentally Handicapped in Calgary

Computer Assisted Instruction (CAI) uses time-sharing terminals to facilitate a man-machine interaction in which the teaching function is accomplished without intervention by a human instructor.

The main attribute of CAI is the individualization of instruction which incorporates training features designed to meet the individual's specific needs. Thus, a CAI system may be designed to provide constant reinforcement, to present material in small logical steps with self-pacing to allow the user with short attention span to receive training for frequent short periods; and it usually requires active participation on the part of the learner.

There is ample documentation to attest to the effectiveness of CAI and it is no longer relevant to question whether the computer should be used as an instructional tool. An extensive and varied amount of research over the past 10 to 15 years has shown conclusively that CAI is an effective and useful means of supplementing traditional instruction.

Most of this research, however, has been concerned with teaching academic skills, usually to normal students attending regular classes. By using special terminal equipment developed for just that purpose, research into the uses of CAI with the mentally handicapped is currently being conducted by the staff and graduate students associated with the Computer Unit of the Department of Educational Psychology, University of Calgary. Simplified input devices developed by Brebner and Hallworth (1976) provide for the special needs of many of the mentally handicapped, by reducing substantially the amount of competence required for the operation of the terminal, including the ability to handle written symbols and to operate a keyboard.

This research is concentrating on teaching social skills to mentally handicapped adolescents and young adults at the Christine Meikle School (CMS) and the Vocational Research and Rehabilitation Institute (VRRI) in the Calgary area.

The result of this research clearly demonstrates that the mentally handicapped can learn such social skills through their interaction with CAI, and, as Hallworth, Brebner and Brown (1974) point out, such interaction is technically practicable as well as effective.

One of the earliest of these studies was conducted by Sandals (1973) who used CAI as a means to teach banking skills to mentally handicapped young adults at the VRRI. These skills included budgeting, opening and using savings and chequing accounts at a bank, and balancing their statement register. He reported that significant learning took place, and concluded that the computer may be an effective means of instruction in social skills with the retarded learner.

Strain (1974) designed a CAI system to teach simple buying skills to the mentally handicapped. He reported that his subjects significantly improved their ability to evaluate the money available for a given purchase and to anticipate and identify the correct change.

A pilot study to teach grocery shopping to cerebral palsied trainees at the VRRI was designed by Holz (1976). By utilizing POSSUM controls for their CAI interaction, the trainees controlled their own speed of presentation of the instructional material and of the test questions. A significant improvement was reported in the shopping behavior of all participating trainees.

Eaton (1975), using a touch sensitive panel in his investigation of the effectiveness of CAI in promoting the visual discrimination of alphabetic letters, found that his subjects improved to a statistically significant extent through their interaction with the CAI programs.

Holz (1976) investigated the effectiveness of CAI for teaching a social sight vocabulary to mentally handicapped adolescents. Her results strongly indicated that CAI is a viable and effective method of teaching such social skills.

The results of these studies confirm the need for instruction in the social skills for the mentally handicapped. They also show that these skills can be successfully taught by CAI with little or no teacher intervention.

The practical application of these results may be observed at the VRRI where CAI has become an integral part of their prevocational program. Located in a large room specifically designed for this purpose, seven

terminals provide the trainees with a variety of programs ranging in difficulty from simple counting exercises to complicated budget problems.

At the Christine Meikle School a part-time CAI project was in effect from February to May 1978. This project included a program specifically developed for the school. It provided drilling exercises in simple arithmetic for the very low functioning students who could count only to 4 or 5, to the more advanced students capable of adding two numbers totalling up to 19. A coin recognition program was also in use. The students were shown slides of one or more coins and were asked to total the value of these coins.

Statistical analysis of this project indicated a very real gain for all participating students confirming that the effectiveness of CAI as reported in research settings is also applicable in applied situations.

Purpose of the Project

There were several reasons why this study was undertaken at this time:

1. If this problem could be satisfactorily solved for this population, these programs would be available to any Special Education student in a school system with access to the appropriate terminal equipment and a telephone, thus adding a new and important dimension to the quality of education for all mentally handicapped children in the Province.

2. This study can serve as a pilot study for more extensive curriculum building projects utilizing CAI with the mentally handicapped.

3. The Vocational Research and Rehabilitation Institute in Calgary which has made CAI an integral part of its training program has developed a series of programs which teach coin calculations beyond $1.00, as well as budgeting and banking skills. All of these programs are available to the school system, and can be used for further training of those students who successfully complete the training outlined in this study.

4. Technical support was available. The appropriate terminal equipment, currently in use at the school, is on loan from the Computer Application Unit, the Faculty of Education, until the end of the school year. The Computer Application Unit also provided computer time and storage. All these facilities were provided at no cost to the school since the researcher is enrolled in a graduate course in Computer Applications at the University.

Ideally, individualized instruction should be available to every student in any school system, for maximum learning and potential growth. This study suggests how this may be accomplished, through the use of technological advancement, for the students in Special Education, an area in which the need for such instruction is particularly great.

CHAPTER II

DESIGN OF THE PROJECT

The Hardware

The equipment used for the study consisted of a Cathode Ray Tube (CRT) terminal interfaced with a random access slide projector, and a hard copy teletype terminal. Using an acoustic coupler these terminals were connected to the computer by a single telephone line. The computer, a time-sharing system based on a PDP-11/70 Central Processor, is located in the Faculty of Education at the University of Calgary.

The Courseware

The courseware was designed in four modules, each of which dealt with a concept necessary for successful handling of coins up to 99 cents. These concepts included numeral recognition, counting to 99, simple additions, and coin recognition.

The modules were organized into steps or number levels, corresponding to each of the numbers from 1 to 99 being dealt with during the training.

The number levels were not individually programmed although some levels were emphasized more than others. Thus, number levels 1 to 10 received more drill than subsequent ones, as did the number levels which introduced a new coin.

Module 1 introduced to the student the number to be dealt with at a given number level. For numbers equal to or less than 10 a 3-step fading technique was used. Firstly, a large CRT screen display of the number was presented to the student who in turn responded with pressing the appropriate key on the keyboard. Secondly, the slide projector, activated by the computer program, displayed the number in a size approximately one third of the above. Again, the student matched the number to the key on the keyboard and entered his response. Thirdly, the number was shown on the CRT screen in regular type size and the student responded as previously.

For numbers greater than 10 and up to and including 25, the last two steps were employed. For numbers greater than 25, only the third step of the presentation was used. Every number in the range from 1 to 25 was included in the training. Numbers beyond 25, however, were randomly chosen for inclusion, one number in each group of five. Table 1 lists the numbers beyond 25 which were included in the training.

TABLE 1

RANDOMLY ASSIGNED NUMBERS BEYOND 25

RANGE	N
26-30	28
31-35	32
36-40	37
41-45	45
46-50	47
51-55	54
56-60	58
61-65	61
66-70	67
71-75	73
76-80	76
81-85	81
86-90	90
91-95	92
96-100	99 - this number was not randomly assigned.

Module II was concerned with counting exercises. A CRT screen display of small boxes were presented to the student who counted them and subsequently entered his response via the keyboard. Each box was represented by the following three characters: ⟨:⟩ . The boxes were displayed singly or in groups corresponding to the value of each coin inolved in a given combination of coins at that particular number level. Thus, a nickle (5¢) was represented by a vertical string of five boxes. A dime (10¢) was represented by two closely placed vertical strings of five boxes each, and a quarter (25¢) by five such strings. The boxes representing pennies (1¢) were always displayed horizontally. At no time were more than five pennies part of one combination of coins.

The number of counting problems presented to the student at a given number level varied according to the number of possible coin combinations for that number. For smaller numbers such as 7 only one problem was presented, e.g. ⟨:⟩ ⟨:⟩ ⟨:⟩
⟨:⟩
⟨:⟩
⟨:⟩
⟨:⟩

For larger numbers such as 16, a total of two problems were presented, et. ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ and ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩
⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩
⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩
⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩
⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩ ⟨:⟩

Module III presented simple addition problems to the student. These problems were identical to the display of boxes offered in Module II except that the actual numbers were shown rather than boxes.

Thus, the addition problem related to the number 7 was shown as 5+1+1= ; the two problems related to 16 were shown as 10+5+1= and 5+5+5+1= ; and a total of five problems were presented for 20 (e.g. 10+5+1+1+1+1+1, 5+5+5+1+1+1+1+1, 5+5+5+5, 10+5+5, and 10+10). To keep the project within a manageable size only two problems were presented for numbers beyond 25 (e.g. 45: 25+5+5+5+5 and 25+10+5+5).

At the conclusion of this module, the student was given three test questions to ascertain that he had understood the material associated with numbers up to the present one.

Module IV presented a series of slides of coins and combinations of coins. The number of slides presented at a number level varied according to the number of coin combinations which were taught at that particular number level and which corresponded to the problems presented to the student in Modules II and III.

Generally, a total of four slides were shown for each coin combination; the first slide presented the coins arranged horizontally with a label below showing the value of each coin separated by plus signs, similar to the CRT screen display of the problem in Module III. The second slide showed an identical arrangement of coins but without the label. The last two slides in the series depicted the coins in a scattered pattern. The student totalled the value of the coins for each slide and entered his response via the keyboard.

Feedback was provided throughout the training session. When a correct response was received, the words "YES, THAT IS CORRECT" were

displayed on the CRT screen and the student continued the lesson. If his response was incorrect, the words "NO, TRY AGAIN" were displayed and a remedial routine was activated according to the appropriate module. Thus, if the error occurred in the counting module, a numbering of the boxes already displayed on the CRT screen would appear. The remedial routine for Module II included a CRT screen display of the appropriate number of boxes involved in that particular addition problem. An error in Module IV would cause the first slide for that number level to be displayed again. This slide showed the coins in a horizontal display with the value label immediately below.

If the student's repeat response was incorrect after the remedial routine, he was provided with the correct answer via the CRT screen before proceeding to the next presentation and his failure was recorded on his record for later evaluation.

When a student successfully completed a number level, a slide of red stars was shown. Upon completion of the day's training session, the student was presented with a slide of gold stars.

A total of 315 slides were used in the study. These were taken by an ASAHI Pentax 35mm single reflex camera with Ektachrome high speed films. To ensure maximum effect of each slide, care was taken to adhere as closely as possible to the basic rules of structure and consistency, so essential in the training of the mentally handicapped:

1. The coins used in the slides were close to mint condition
2. The coins were all photographed against the same black background, which, when projected, appeared as dark blue

3. The coins were always arranged in such a way that the greatest denomination coin was shown in the left, or upper leftmost, position of the slide with the lowest denomination coin in the right, or lower right, position

4. The coins were photographed in such a manner that the cent value of each coin was clearly shown

5. Only Canadian coins issued within the last 5 years were used for the slides.

The Software

The CAI system used in the study consisted of a series of programs written in BASIC-PLUS, a high-level language supplied on the PDP-11/70 computer system.

The programs were chained together in related modules to form a complete training program, and were structured in such a way that they could accommodate those students just learning to recognize numbers, as well as those able to count to 100. Although the modules followed a sequential developmental design, it was by no means necessary for a student to complete one module before advancing to the next. Thus, for example, if a student had mastered addition up to 5, he was passed along the chain to drill in simple coin recognition, through to the modules which dealt with adding 5 pennies, and introduction of a nickel.

The CAI system was designed to give the student control over the speed of presentation of the material, and a record was kept of the total length of time a student spent at each number level, as well as the

number of times each level was presented to him.

A failure criterion for each number level was defined as three errors in any one module. When this criterion was reached for the first time at one number level, that level was repeated. If, during the repetition, he failed again, the student was branched back one number level, thus providing overlearning according to the individual's needs.

The system, however, was designed in such a way that no student finished the day's session with a failure; upon reaching a failure criterion at the end of the day's lesson, the student was presented with a few problems which, according to his record, he would be able to handle. At the completion of a training session the student's record was updated with the results, including the starting point of the next session.

CHAPTER III

THE INVESTIGATION

The Sample

The study was conducted in Calgary at the Christine Meikle School, a school for trainable mentally handicapped children.

Initially, 62 junior and senior students were selected for training. Of these, 14 were eliminated by the pre-test; 1 because she already knew the numbers to be taught, 2 because of their refusal to cooperate, 4 because of zero scores and 7 because no match was available for them. Of the remaining 48 students, 32 were paired according to the pre-test results and were randomly assigned to either the study group or the control group. The chronological age range for the sample at the time of selection was from 7 years, 4 months to 20 years, 11 months with the mean age being 15 years, 6 months. The estimated I.Q. ranged from 31 to 53 with a mean of 41. The mean mental age for the sample was 5 years, 1 month with a range from 2 years, 9 months to 6 years 8 months.

Administration

The terminals were located in a small room used exclusively for CAI purposes and were available to the students throughout the school day from 9:00 a.m. to 12:20 p.m. and again from 1:00 p.m. to 3:00 p.m.

The training began on January 16th and lasted until March 2nd. During this period a total of 4 days were lost; 1 day due to computer maintenance and 3 days due to Teachers' Convention and Professional Days.

Measures

The test used to measure the effectiveness of the study was devised by the experimenter because no other such instrument was available for this purpose. It consisted of seven sets of numbers according to Table 2, and was in two parts as follows:

PART 1

One slide for each number level in a set was presented to the student. The slide was identical to one of the slides used in the training of that number and depicted the appropriate coins photographed in the scatter pattern.

If one or more slides in a set of numbers were correctly identified, the test continued to the next set. If no correct response was received, the testing was discontinued and a zero score was recorded for all subsequent number levels.

The reason for the discontinuation was based on the assumption that if a student did not correctly add up to the amount involved in a given number level, it was unlikely that he would be able to add amounts higher. Presenting up to 40 slides he did not understand would cause him unnecessary frustration.

TABLE 2

PRE AND POST TEST

SEQUENCE OF PRESENTATION OF SETS OF NUMBERS

	Order of Slide/Coins Presentation				
GROUP I	Nickle	Quarter	Dime	Penny	
GROUP II (1¢ - 5¢)	4¢	3¢	1¢	2¢	5¢
GROUP III (6¢ - 10¢	9¢	8¢	6¢	7¢	10¢
GROUP IV (11¢ - 15¢)	14¢	13¢	11¢	12¢	15¢
GROUP V (16¢ - 20¢)	19¢	18¢	16¢	17¢	20¢
GROUP VI (21¢ - 25¢)	24¢	23¢	21¢	22¢	25¢
GROUP VII	Each of the 15 number levels involved from 26¢ - 99¢ presented sequentially.				

PART 2

To ascertain if any transfer from slides to coins had taken place, the second part of the test was administered immediately following the first part. It was identical to the above except actual coins were presented to the student rather than slides of the coins.

Because no audio support was provided during the training, a verbal response to the questions was not essential. To help the student respond non-verbally, a chart with numbers was provided. Touching the appropriate number on this chart was accepted as a correct response.

No cueing was allowed nor was any feedback provided. The responses were rated 0 or 1 according to the content of the response.

The scores from the post-test administered to both the groups immediately following the training period were used to ascertain the effectiveness of computer assisted instruction in teaching basic money handling skills to mentally handicapped students. A correlated t-test was used for this evaluation.

Although matching by pairs on a relevant variable, e.g. the post-test score, followed by random assignment improves the rigour and precision of the design, it should be noted that the underlying assumption of random selection was violated because the subjects were selected on the basis of their availability and entering behavior rather than by a randomization process. Consequently, it would be inappropriate to generalize any findings to the population of mentally handicapped students.

CHAPTER IV

RESULTS

Student's Reaction

In order to investigate if the basic money handling skills could be taught to the students at the Christine Meikle School through their interaction with computer assisted instruction, a sample of 16 students was chosen to receive such training. All the students commenced their lessons at the beginning point of the program then progressed through the training at individual speeds. Thus, one student never went beyond the number level 6 while others went well past number level 25.

The students reacted very positively to their training and to the research assistants who supervised them at the terminal.

All the students learned the operation procedures very quickly and at no time did they mistreat the equipment or attempt to touch the peripheral equipment.

Throughout the training, the students appeared interested in their work and eagerly contributed to the CAI interaction.

Personnel

The support and cooperation of the principal and the staff greatly assisted the researcher in the study. Several teachers requested and received demonstrations during their lunch break. Although the study must have caused some annoying interruptions to their classroom routines, no teacher involved voiced any complaints.

Scheduling

The reliability of the computer and the terminals remained high throughout the experimental period permitting constant use with smooth running for the entire school days.

The students were scheduled to receive a daily 20 minute training period each. This period, however, varied according to the wishes and needs of the individual student. Upon completion of a number level within his time period, the student was asked if he wished to continue, if he chose to continue he was allowed to complete that number level even if his time period was up. One junior girl whose attention span was much shorter than that of the other students usually had her daily lessons interrupted by the research assistant after 10 minutes of computer interaction because of her disruptive behavior.

Scoring

A total of 88 points, two points for each of the 40 number levels and 8 points for each of the four coins involved, was the maximum score attainable for both the pre-test and the post-test.

The answers were rated 1 for a correct response and 0 for an incorrect response. Appendix A provides an example of a set of test scoring sheets.

The mean score for the post-test for the study group was 27.2 with minimum and maximum scores of 13 and 68 respectively. For the control group, the mean score was 19.1 with a minimum score of 8 and a maximum score of 57.

The post-test scores for each pair of subject, and the means for each group, are given in Table 3.

TABLE 3

POST-TEST SCORES FOR STUDY GROUP AND CONTROL GROUP

Pair of Subject	Study	Control
1	13	11
2	18	10
3	14	11
4	15	11
5	18	13
6	17	15
7	25	16
8	17	17
9	28	18
10	60	39
11	68	57
12	14	8
13	26	18
14	21	18
15	26	18
16	55	26
	435	306
Means	27.2	19.1

To determine the effect of the students' interaction with the CAI system, the mean scores for the post-tests for the two groups were compared.

A correlated t-test yielded an observed value of $t = 4.312$. In evaluating this, a non-directional test was used, because there was no previous body of research which would justify the use of a directional test. This t-value is significant beyond the .001 level of confidence.

It may be concluded that the basic money handling skills of the mentally handicapped students at Christine Meikle School did improve significantly through their interaction with CAI.

A summary of the observed t-value is given in Table 4.

An examination of the mean scores as graphed in Figure 1 verifies the difference shown by the t-test.

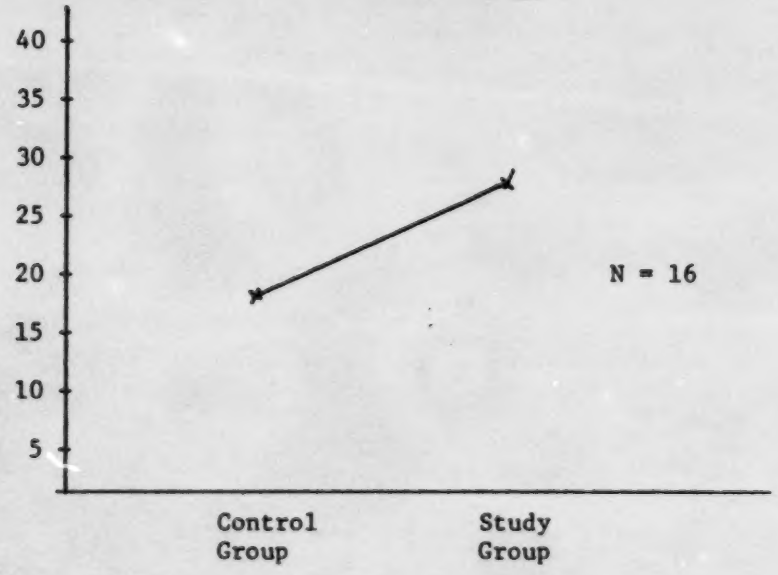
TABLE 4

CORRELATED T-TEST : COMPARISON OF MEAN SCORES ON POST-TEST FOR STUDY GROUP AND CONTROL GROUP

Post-test	Observed t-values	N	df	Significance
All scores	4.312	16	15	.001

FIGURE 1

MEAN POST-TEST SCORES FOR BOTH GROUPS



To demonstrate that this difference may be attributed to the CAI programs rather than to the ongoing programs conducted in the various educational settings throughout the school, the correlated t-test was also applied to the pre-test/post-test scores for each of the two groups. It yielded a value of $t = 4.754$ for the study group and a value of $t = 2.954$ for the control group. These findings indicate that while learning took place for both the groups, the difference was more marked for the study group.

A summary of the observed t-values is given in Table 5, together with their levels of significance.

TABLE 5

CORRELATED T-TEST : COMPARISON OF MEAN SCORES ON PRE-TEST AND POST-TEST FOR STUDY GROUP AND CONTROL GROUP

Group	Observed T-Values	N	df	Significance
Study	4.754	16	15	.001
Control	2.954	16	15	.01

CHAPTER V

DISCUSSION AND CONCLUSION

CAI Interaction

The results of the study clearly demonstrate that the basic money handling skills of the students improved to a statistically significant degree through their interaction with the CAI programs.

Other factors, however, may also have contributed to these results:

1. The novelty of using the CAI programs
2. Being singled out for training
3. Reduction of external stimuli in their immediate surroundings

The novelty of interaction with the computer may have had a lesser effect with this group than is often the case, because many of the participating students had received previous exposure to computer assisted learning. However, they did appear to show a great deal of interest in, and to enjoy, the slide and CRT screen displays.

The effect of being singled out for training was apparent in the student's behavior; they usually anticipated their turn on the terminal with eagerness and pleasure.

The relative bareness of the room in which the CAI equipment was located, the lack of windows in the room, and the absence of other students probably aided the students' power of concentration and improved their attention spans.

Other factors which are a function of individualized instruction in general rather than of CAI specifically, and which have previously been shown to assist the learning process, may also have influenced the results of the study.

These are:
1. Active involvement in the training process
2. Self-pacing
3. Repetition of the material

At no time was the student's role reduced to that of a spectator because, in order to continue with the presentation of the material, the student was required to register his response via the terminal keyboard throughout the entire training period. Thus, active participation was an integral part of the CAI system.

The students had full control of the speed of presentation of the CAI material. The rate at which the students completed a number level, however, varied greatly. A timing device incorporated in the computer programs measured and accumulated the actual time the students spent at each number level. Thus, the longest response time measured for number level 1 was 289 seconds and the shortest was 141 seconds. The mean time for this level was 220 seconds. The time increased markedly for all the students as they approached unfamiliar number levels.

The students responded actively to the feedback provided throughout the training and they greeted the star slides with signs of pleasure.

Repetition of a number level was not perceived by the students as a punishment. The number of such repetitions varied with 16 being the greatest.

The Number Levels

In order to extract information on the number levels included in the study, the students in the study group were divided into two groups according to the post-test scores. The relevant data for each student in the high scoring half of the group (High group) are listed in Table 6. Table 7 shows the data for the students in the low scoring half of the study group (Low group).

TABLE 6

PRE-TEST AND POST-TEST RESULTS FOR HIGH SCORING HALF OF STUDY GROUP

				PRE-TEST			POST-TEST		
Subject	I.Q.	M.A.	C.A.	Total Score	Number Level	Coin Level	Total Score	Number Level	Coin Level
7	43	6-2	16-3	14	3	3	25	8	9
9	42	5-7	17-8	16	5	3	28	10	10
10	39	5-11	16-8	33	13	13	60	26	26
11	46	4-9	18-3	42	16	18	68	31	29
13	48	5-6	14-0	16	4	4	26	9	9
14	44	5-8	14-8	18	5	5	21	7	6
15	53	5-4	13-8	18	5	5	26	9	9
16	43	4-3	16-8	23	11	4	55	22	25
	358			180			309		
Mean:	44.8	5-4	15-10	22.5			38.6		

TABLE 7

PRE-TEST AND POST-TEST RESULTS FOR
LOW SCORING HALF OF STUDY GROUP

				PRE-TEST			POST-TEST		
Subject	I.Q.	M.A.	C.A.	Total Score	Number Level	Coin Level	Total Score	Number Level	Coin Level
1	40	4-0	13-8	9	4	4	13	5	5
2	39	2-9	11-3	13	5	2	18	5	5
3	49	5-4	13-8	7	2	2	14	4	4
4	31	4-0	16-10	8	0	0	15	4	3
5	40	6-2	18-1	11	1	2	18	5	5
6	34	-	14-0	12	2	4	17	5	5
8	42	4-3	14-5	15	5	4	17	5	5
12	35	3-10	15-3	6	1	0	14	5	5
	310			81			126		
Mean:	38.8	4-3	14-6	10.1			15.8		

Generally, the post-test scores for the High group were much higher than those for the Low group with a range from 21 to 68 and a mean of 38.6 versus a range 13 to 18 and a mean of 15.8 respectively.

An examination of the post-test score sheets for the study group reveals that no student in the Low group went beyond the number level 5, that is, six out of the 8 students could count the five pennies on the slide as well as in actual coins but could not handle higher amounts, whereas all the students in the High group went beyond number level 5.

It appears that for number levels up to and including 5 the Low group students learned to master the concept of 'how many' but could not

comprehend and switch to the concept of 'how much'. An examination of the errors made during the training shows that the most common error committed by any student at number level 6 was counting the coins rather than the value of the coins, that is, a '2' response was recorded instead of a '6' answer. The High group experienced no such difficulty.

A tally of the number of repetitions for each of the two sub groups, as recorded on the individual Final Report, indicates that the Low group repeated number level 6 an average of 10 times versus 2.3 times for the High group.

Appendix B provides an example of a Final Report.

Further examination of the post-test score sheets shows that students in the High group experienced some difficulty at number level 10 and again at number level 25, both of which are levels where a new coin was introduced. The most frequently occurring errors at number levels 10 to 15 were committed when the students were asked to total a combination of coins involving two nickels rather than one dime.

A summary of the means of the data shown in Tables 6 and 7 are listed in Table 8. An examination of this data reveals that the students in the Lower scoring half of the study group tend to be lower functioning in general as indicated by the I.Q. score and the Mental Age (M.A.) as well as younger as shown by the chronological age (C.A.).

TABLE 8

COMPARISON OF MEANS FOR STUDY GROUP

	I.Q.	M.A.	C.A.	Pre-test Scores	Post-test Scores
All subjects	41.8	4-9	15-3	16.3	27.2
High Group	44.8	5-4	15-10	22.5	38.6
Low Group	38.8	4-3	14-6	10.1	15.8

There appeared to be no problems for the students to transfer their coin recognition from slides to actual coins.

One matched pair of students (subject #1) was non-verbal and consequently responded to the pre-test and post-test questions by pointing to a chart with numbers. Neither student performed well on the test, but because of inconclusive data it would be inappropriate to generalize any findings to a non-verbal population.

It should be noted that no attempt was made to test the retention of the material learnt during the training.

Limitation of the Study

Although the small sample size of 16 was statistically manageable, a larger one would have been used had more eligible students been available for the study.

With the relatively limited time available for the study, it is not known if the students in the high scoring half of the study group would

have continued to improve with more training, or how much they would have improved, nor is it known if the low scoring half would eventually have been able to discriminate between 'how many' and 'how much'.

The study did not include a test of retention, consequently it was not established for how long, and to what degree, the students retained the information learned.

Conclusion

The findings of this study, as it was carried out, indicate that computer assisted instruction offers a viable and effective method of teaching basic money handling skills to trainable mentally handicapped students who can interact with the CAI programs.

Suggestions for Further Research

The results of this study revealed that the lower functioning students learned to count coins, but not to compute the value of the coins, that is, they correctly counted 5 pennies, but the sum of 1 nickle + 1 penny was perceived as 2. Future programs to teach the lower functioning students the difference between the concepts of 'how many' and 'how much' are urgently needed.

A study is also needed to investigate the usefulness of audio support in a CAI project of this nature.

Finally, because an analysis of the data generated by this project indicate that the average computer processing time involved in a 5½ hour period of computer interaction was less than one minute, the use of micro computers for this type of CAI usage should be investigated.

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APPENDIX A

Name: _____ 32

	24
	23
VI	21
	22
	25
	28
	32
	37
	45
	47
VII	54
	58
	61
	67
	73
	76
	81
	85
	91
	99

Pretest			
Slide		Coins	
Score	Time	Score	Time

Posttest			
Slide		Coins	
Score	Time	Score	Time

APPENDIX B

FINAL REPORT

I.D. : 20 NAME : [redacted] DATE : 01-MAR-79
SEX : M

MENTAL AGE	CHRONOLOGICAL AGE	I.Q.	PRE-TEST	POST-TEST
403	1608	43	23	9999

LEVEL	TOTAL START : FINISH
29	1 : 28

LEVEL	VALUE	NUMBER OF REPETITIONS	TOTAL TIME (MIN:SEC)
1	1	1	2:47
2	2	1	1:57
3	3	1	1:57
4	4	3	2:29
5	5	1	2: 8
6	6	1	1:52
7	7	1	1:53
8	8	1	1:58
9	9	1	2: 1
10	10	1	3:52
11	11	3	6: 9
12	12	3	6:33
13	13	3	6:11
14	14	3	9:19
15	15	3	15:40
16	16	3	9:15
17	17	3	12:37
18	18	3	12:23
19	19	3	15:28
20	20	4	24:31
21	21	3	13:38
22	22	3	15:11
23	23	3	16: 0
24	24	1	4:58
25	25	3	27:34
26	28	3	18: 3
27	32	3	24:48
28	37	4	38:15